Check List the journal of biodiversity data

NOTES ON GEOGRAPHIC DISTRIBUTION

Check List 19 (2): 169–175
https://doi.org/10.15560/19.2.169

PENSOFT

Occurrence of *Pheidole tijucana* Borgmeier, 1927 (Hymenoptera, Formicidae) in the state of São Paulo, Brazil

Débora Cristina de Oliveira Gonçalves[1], Lívia Pires do Prado[2], Fabrício Severo Magalhães[1], Marlina Ribeiro Abonizio-Santos[1], Maria Santina de Castro Morini[1*]

1 Laboratório de Mirmecologia do Alto Tietê, Núcleo de Ciências Ambientais, Núcleo de Ciências Ambientais, Universidade Mogi das Cruzes, Mogi das Cruzes, SP, Brazil • DCOG: debora_cog@outlook.com https://orcid.org/0000-0002-3739-9786 • FSM: fabricio-severo.fa@gmail.com https://orcid.org/0000-0002-7173-658X • MRAS: marlinaribeiro@live.com https://orcid.org/0000-0002-6637-7236 • MSCM: mscmorini@gmail.com https://orcid.org/0000-0002-1823-6703

2 Laboratório de Hymenoptera, Museu de Zoologia da Universidade de São Paulo, São Paulo, SP, Brazil • livia.pires7@gmail.com https://orcid.org/0000-0003-1819-8767

* Corresponding author

Abstract. *Pheidole* Westwood, 1839 is a hyperdiverse ant genus that is widely distributed in a variety of terrestrial ecosystems, especially in the tropics. The identification of *Pheidole* species is challenging, thus contributing to the description of several questionable morphospecies in the literature and making the geographic distribution of most species uncertain. In this work, we present the first records of *Pheidole tijucana* Borgmeier, 1927 from the state of São Paulo, Brazil. The specimens were recorded at Parque Ibirapuera Conservação, an urban green area located in the southern part of the city of São Paulo. The sampling was performed in 2015, 2016, and 2017 using pitfall traps. In total, 224 specimens (one major worker and 223 minor workers) of *P. tijucana* were recorded. Our new data help fill a distribution gap and highlights the importance of reporting species that are a challenge to identify.

Keywords. Atlantic Forest, biodiversity, Myrmicinae, urban green area, urban park

Academic editor: Sandor Buys
Received 25 January 2023, accepted 5 March 2023, published 14 March 2022

Gonçalves DCO, Prado LP, Magalhães FS, Abonizio-Santos MR, Morini MSC (2023) Occurrence of *Pheidole tijucana* Borgmeier, 1927 (Hymenoptera, Formicidae) in the state of São Paulo, Brazil. Check List 19 (2): 169–175. https://doi.org/10.15560/19.2.169

Introduction

Pheidole Westwood, 1839 (Myrmicinae) is a hyperdiverse ant genus with more than 1,000 valid species and subspecies, which are widely distributed around the world. In the Americas, *Pheidole* is the richest genus of Myrmicinae (Kempf 1972; Wilson 1976), having been recorded in the most varied environmental conditions and habitats (Economo 2015), in disturbed (Ješovnik and Bujan 2021), preserved (Jahan 2022), and regenerating areas (Aguiar 2022). Around 700 species are found in the Neotropical Region, 200 of which occur in Brazil and 60 of which occur in the state of São Paulo (Janicki et al. 2016).

Pheidole species display morphological and behavioral traits that enabled a great adaptive success (i.e., the division of labor in two morphologically distinct castes; loss of a functional sting; the complete absence of ovaries in the worker castes) (Hölldobler and Wilson 1990; Wilson 2003). Nesting and foraging occur mainly in deeper soil layers, or above or between the interstices of the leaf litter (Delabie et al. 2000; Casadei-Ferreira 2021). In the leaf litter, *Pheidole* may occupy fruits, seeds, and wood in varying degrees of decomposition (Castaño-Menzes et al. 2015; Casadei-Ferreira 2021), and the latter includes twigs (Fernandes et al. 2019). Barroso et al. (2020) and Almeida et al. (2021) suggested that the occupation of twigs by species of *Pheidole* could be due to a process of selection.

Pheidole tijucana Borgmeier, 1927 belongs to the

©The authors. This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

fallax group (Wilson 2003), although its biology remains unknown. The species was described in 1927 by Borgmeier, based on 15 major workers and 12 minor workers collected by him in Tijuca, a neighborhood in the city of Rio de Janeiro (Rio de Janeiro state, Brazil). Many decades later, this species was again recorded, this time from the state of Bahia (Santos et al. 2017), in remnants of the Atlantic Forest at different regeneration stages; Santos et al. used pitfall traps and Winkler extractors to collect the specimens. Although São Paulo is one of the Brazilian states best-sampled for its ant fauna, no other records of *P. tijucana* have been recorded since, even in the recent updates on the Atlantic Forest species (Feitosa et al. 2021; Silva et al. 2022). Given the scarcity of information on *P. tijucana*, we report the first records of this species from the state of São Paulo.

Methods

The specimens were collected in an urban green area, Parque Ibirapuera Conservação, which is in the city of São Paulo. The park is within the Brazilian Atlantic Forest domain (Ribeiro et al. 2009); it has an area of 1,584 m^2 and is composed of mixed woodland with *Eucalyptus* and other exotic species, as well as native species. There are flower beds, lawns, and theme gardens on site, with a total of 532 species of vascular plants, including trees, shrubs, and herbaceous plants. The climate is humid subtropical, characterized by a notoriously dry winter and a rainy summer; temperatures vary between 12 °C during the winter and 28 °C during the summer (annual average temperature 20.3 °C).

Our expeditions to collect specimens were carried out in the summers and winters of 2015, 2016, and 2017 in four areas of the park (Fig. 1). Ants were collected with pitfall traps containing 500 mL of preserving liquid (70% ethanol and 10% formaldehyde); the traps were buried at ground level. In total, 100 pitfall traps were used, with each area having 25 traps. Each trap was placed 3 m away from the next closest trap. The traps remained on site for eight days.

The genus was identified using the key by Baccaro et al. (2015). The species identification used the keys by Wilson (2003). The specimens collected were also compared to the type specimens of *P. tijucana*, which are deposited at Coleção de Hymenoptera of the Museu de Zoologia da Universidade de São Paulo (MZSP). The vouchers were also deposited at MZSP (individually as MZSP67490, MZSP67491, MZSP67492, and MZSP95643) and at the Laboratório de Mirmecologia do Alto Tietê da Universidade de Mogi das Cruzes (LAMAT) (Souza-Campana et al. 2020).

Results

***Pheidole tijucana* Borgmeier, 1927**

Figures 2, 3

New records. BRAZIL – São Paulo • São Paulo, Parque Ibirapuera Conservação; 23°35′38″N, 046°39′52″W;

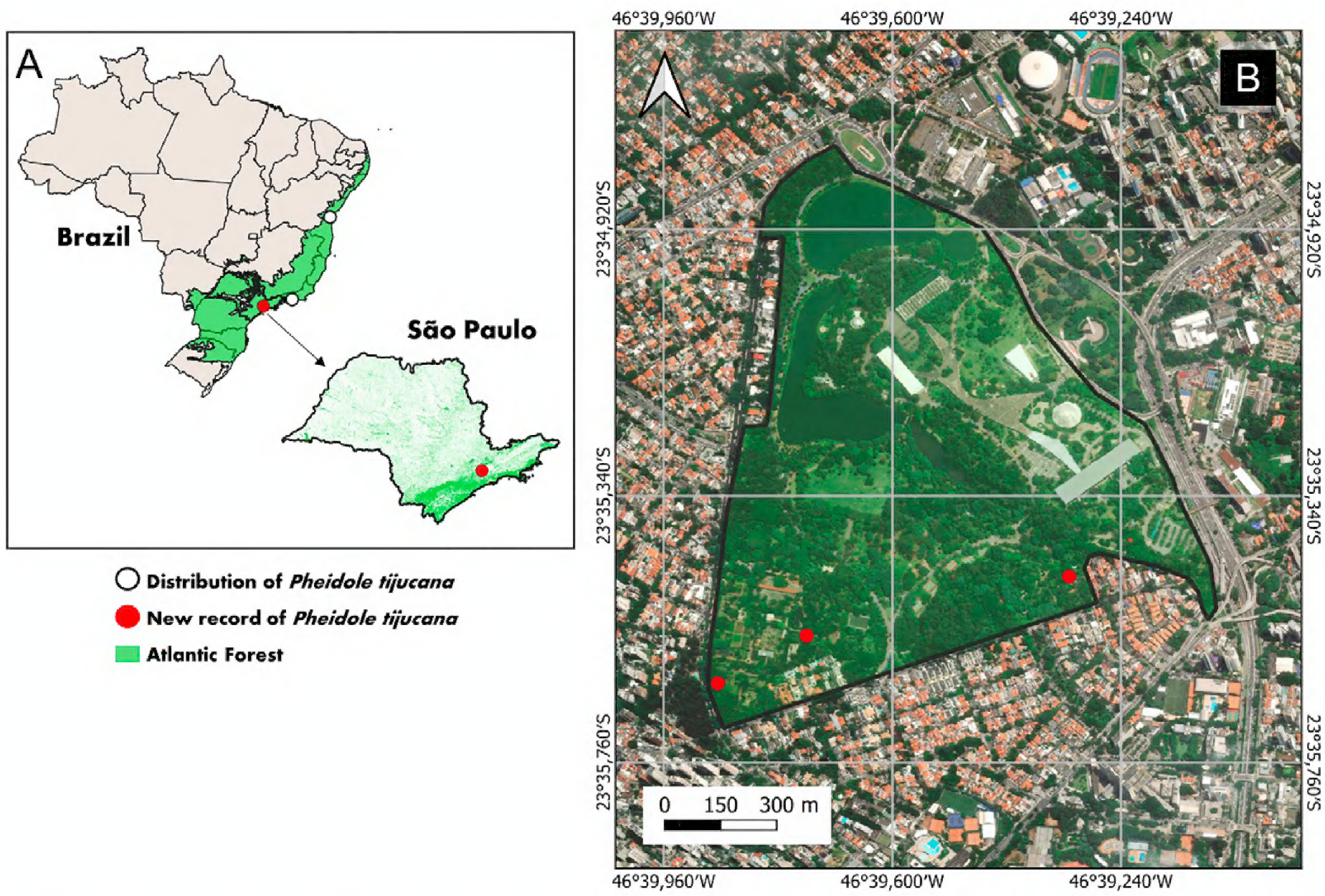

Figure 1. Geographic location of the areas of occurrence of *Pheidole tijucana* in the Brazilian Atlantic Forest. **A.** Study site, São Paulo, Brazil. **B.** Parque Ibirapuera Conservação, in the city of São Paulo.

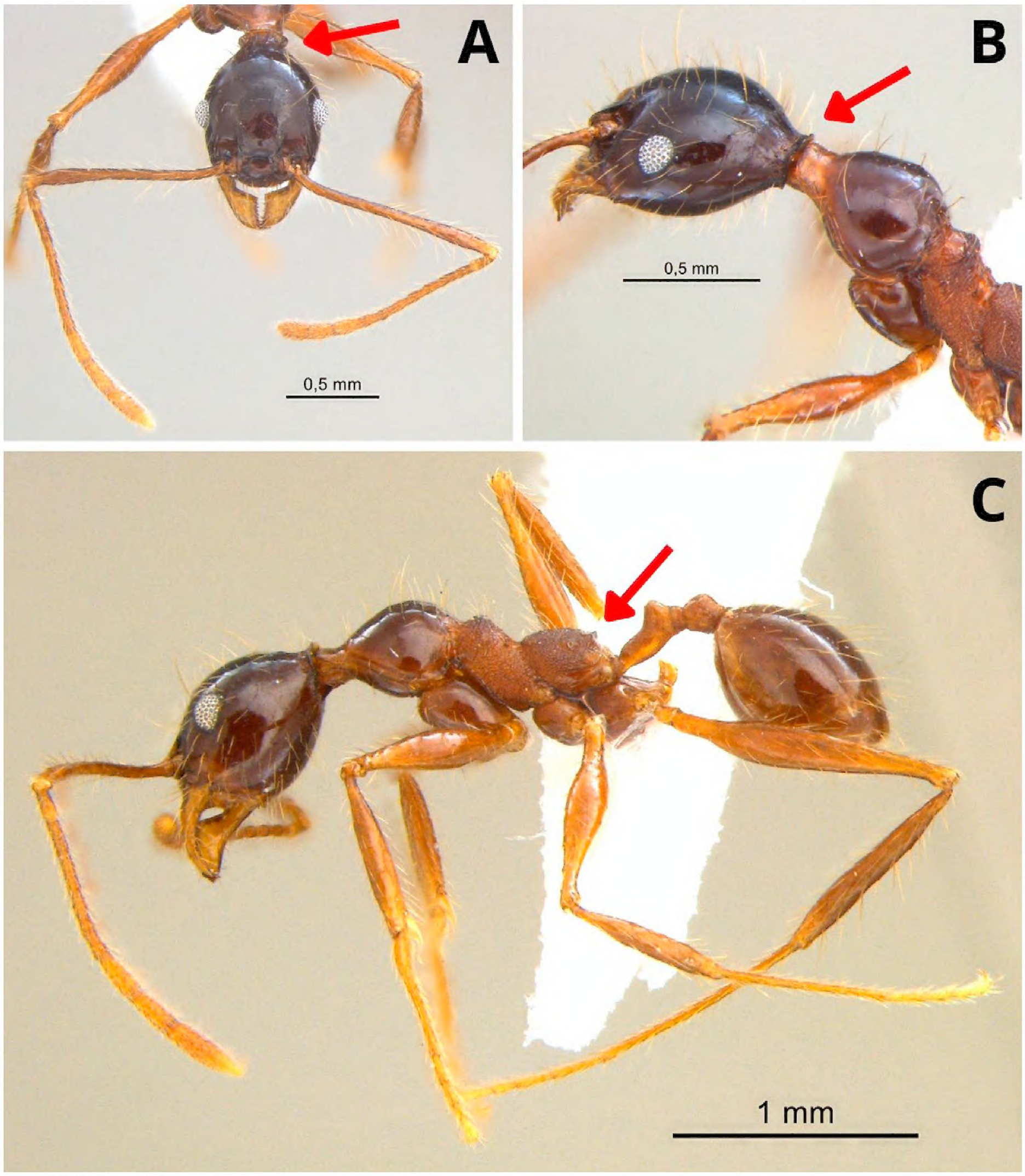

Figure 2. Minor worker of *Pheidole tijucana*. **A.** Head in frontal view. **B.** Latero-dorsal view. **C.** Lateral view.

761 alt.; 29.V.2015; R. Bertani col. leg.; pitfall; 56♀, MZSP; 1 major worker, MZSP95643 • same data, except 23°35′33″N, 046°39′44″W; 757 alt.; 22.V.2015; R Bertani col. leg.; pitfall; 4♀, LAMAT • same data, except 23°35′38″N, 046°39′52″W; 761 alt.; 29.I.2016; R. Bertani col. leg.; pitfall; 108 minor workers, LAMAT; 1♀, MZSP67490; 1 minor worker, MZSP67491; 1 minor worker, MZSP67492 • same data, except 23°35′33″N, 046°39′44″W; 757 alt.; 29.I.2016; R Bertani col. leg.; pitfall; 13 minor workers, LAMAT • same data, except 23°35′28″N, 046°39′19″W; 765 alt.; 29.I.2016; R Bertani col. leg.; pitfall; 1 minor workers, LAMAT • same data, except 23°35′38″N, 046°39′52″W; 761 alt.; 14.IX.2016; R. Bertani col. leg.; pitfall; 16 minor workers, LAMAT • same data, except 23°35′38″N, 046°39′52″W; 761 alt.; 14.II.2017; R Bertani col. leg.; pitfall; 19 minor workers, LAMAT • same data, except 23°35′33″N, 046°39′44″W; 757 alt.; 14.II.2017; R Bertani col. leg.; pitfall; 1 minor worker, LAMAT • same data, except 23°35′28″N, 046° 39′19″W; 765 alt.; 14.II.2017, R Bertani col. leg.; pitfall; 2 minor worker, LAMAT.

Total number of specimens: 223 minor workers and 1 major worker.

Identification. As reported by Wilson (2003), the minor worker of *P. tijucana* can be identified according to

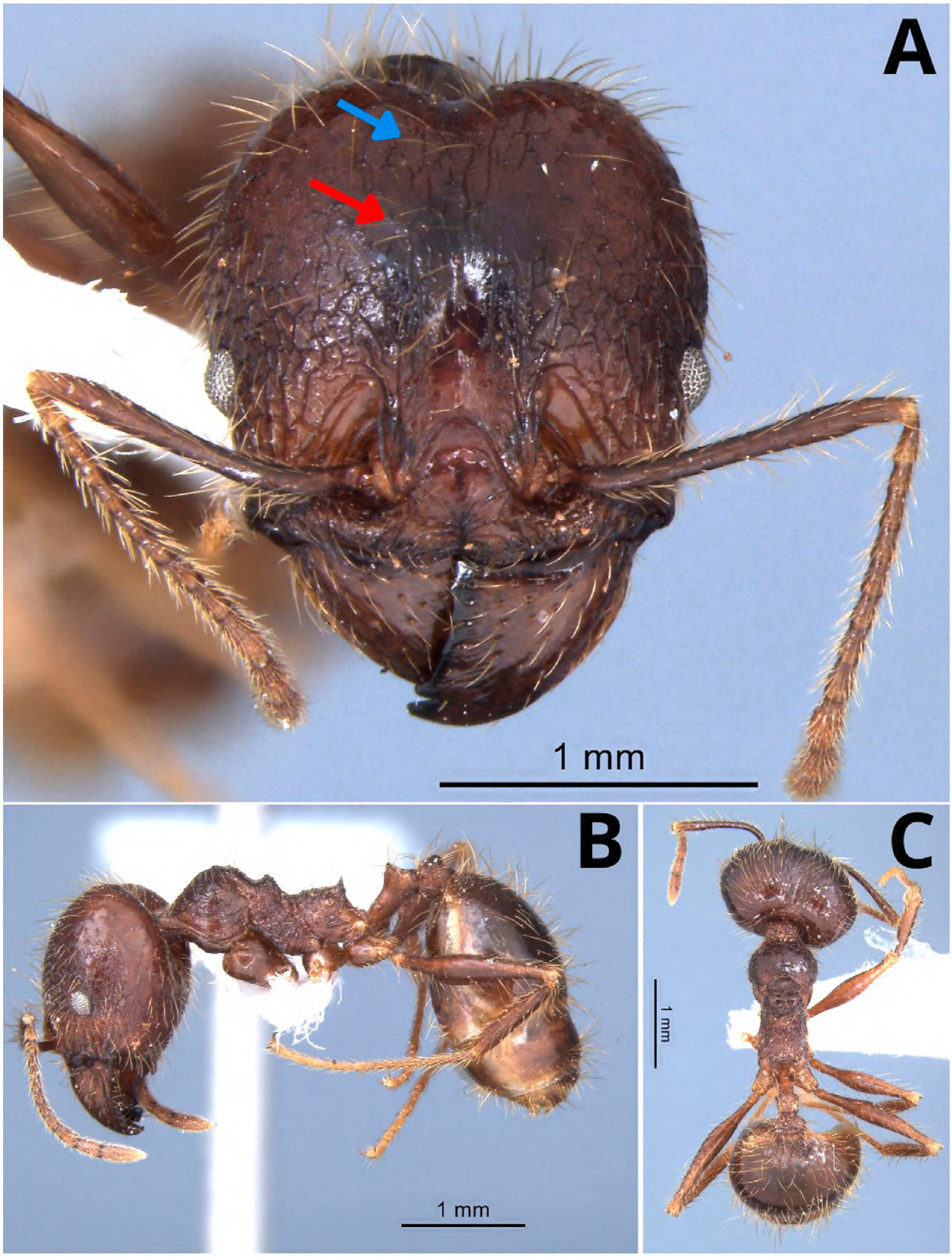

Figure 3. Major worker of *Pheidole tijucana*. **A.** Head in frontal view. **B.** Lateral view. **C.** Dorsal view.

the morphological characteristics of the fallax species group; also, it is distinct from all other species in this group because of the following characteristics: occiput constricted to the neck a with broad nuchal collar (Fig. 2A, B), propodeal spines reduced to denticles (Fig. 2C), and light brown, except for the head, which is a darker, reddish shade (Fig. 2). The major worker (Fig. 3A–C), as reported by Wilson (2003), is morphologically similar to *Pheidole lucretii* Wilson 2003. However, the two species are distinguished mainly by the sculpture on the surface of the head. In *P. tijucana* most of the occiput vertex and frontal lobes are smooth and shiny (Fig.

3A, red arrow), with a presence of short longitudinal carinulae around midline at the occiput (Fig. 3A, blue arrow), whereas in *P. lucreti* the same region of the head is superficially rugoreticulate.

Discussion

Pheidole tijucana was found in an urban green area inserted in the Brazilian Atlantic Forest domain. Our results, as for all previous records of this species (Borgmeier 1927; Santos et al. 2017), suggest that it inhabits dense tropical rainforests. The Atlantic Forest consists of a mosaic of vegetation with distinct forests. One of them is the dense rainforest, which is characterized by very high humidity, high temperatures (average of 25 °C), and high precipitation well distributed throughout the year (0–60 dry days); vegetation is composed of phanerophytes, lianas, and epiphytes (IBGE 2012). This phytophysiognomy presents a wide diversity of ants (Feitosa et al. 2021; Silva et al. 2022), given that in 1 m^2 of leaf litter it is possible to find up to 35 species (Silva and Brandão 2010).

Since the description of *P. tijucana*, many surveys of leaf litter have been carried out in the Brazilian Atlantic Forest (i.e., Delabie et al. 2007; Pacheco et al. 2009; Suguituru et al. 2011, 2013; Silva et al. 2022), including in wood structures that are colonized by species of *Pheidole* (Souza et al. 2012; Fernandes et al. 2019, 2020). Moreover, several surveys have also been made in urban areas of Brazil (Bueno et al. 2017), and *P. tijucana* has not been recorded in any of them. The scarcity of records for *P. tijucana* may indicate that the species is not abundant and has a more limited distribution. However, the low taxonomic resolution of hyperdiverse genera such as *Pheidole* should be taken into consideration (Kempf 1961; Silva et al. 2022). Colonies of the *Pheidole* species typically have hundreds to thousands of workers (minor and major), but here we sampled only one major worker in our sampling, which may reflect the collection method used. In general, minor workers are usually responsible for foraging, while major workers remain mainly inside the nest (e.g., Wetterer, 2007). Thus, it is possible that the species was simply not identified in the above-mentioned checklists, and that its distribution and abundance are actually higher than what is now thought.

The lack of knowledge on the distribution and biology of insect species is alarming, mainly in face of the decline in the populations of these invertebrates (Sánchez-Bayo and Wyckhuys 2019; Wagner 2020). Unfortunately, our comprehension of tropical biodiversity is still severely limited by significant deficiencies in our knowledge of the taxonomy and distribution of species (Hortal et al. 2015). Hence, the occurrence record of *P. tijucana* in the state of São Paulo, in an urban area of a huge metropolis is quite surprising, and it opens new possibilities for the study of its biology.

Acknowledgements

We thank the National Council for Scientific and Technological Development (CNPq, process no. 126691/2021-5) for the undergraduate research fellowship granted to the first author. L.P. Prado acknowledges the São Paulo Research Foundation (FAPESP) for the postdoctoral fellowship (grant no. 2022/01974-8).

Author Contributions

Conceptualization: DCOG, LPP, MSCM. Data curation: DCOG, FSM, MRAS. Formal analysis: DCOG, LPP. Investigation: DCOG, FSM, MRAS, MSCM, LPP. Methodology: LPP. Project administration: DCOG. Supervision: MSCM. Writing – original draft: DCOG. Writing – review and editing: DCOG, FSM, MRAS, MSCM, LPP.

References

Aguiar JJM, Anjos DV, Carvalho RL, Almeida RW, Santos ACC, Santos JC (2022) Plant richness drives ant diversity in *Eucalyptus*-dominated landscape on Brazilian savanna. Austral Ecology 47 (1): 17–25. https://doi.org/10.1111/aec.13060

Almeida RPS, Andrade-Silva J, Silva RR, Fernandes TT, Souza-Campana DR, Silva NS, Morini MSC (2021) Twigs in leaf litter: overlap in twig size occupation by nesting ants. Insectes Sociaux 68 (2): 199–206. https://doi.org/10.1007/s00040-021-00816-6

Baccaro FB, Feitosa RM, Fernández F, Fernandes IO, Izzo TJ, Souza JD, Solar R (2015) Guia para os gêneros de formigas do Brasil. Editora INPA, Manaus, Brazil, 388 pp.

Barroso SC, Longui EL, Fernandes TT, Oliveira CM, Ferreira AC, Silva RR, Morini MSC (2020) Twigs occupied by *Pheidole* Westwood, 1839: is there a difference between species?. Biota Neotropica 20 (2): e20190897. https://doi.org/10.1590/1676-0611-BN-2019-0897

Borgmeier T (1927) Algumas novas formigas brasileiras. Arquivos do Museu Nacional 29: 57–65.

Bueno OC, de Carvalho Campos AE, Morini MSC (2017) Formigas em ambientes urbanos no Brasil. 6 ed. Canal, Bauru, Brazil, 685 pp.

Casadei-Ferreira A (2021) *Pheidole*. In: Starr CK (Ed.) Encyclopedia of social insects. Springer, Cham, Switzerland, 728–731. https://doi.org/10.1007/978-3-030-28102-1

Castaño-Meneses G, Mariano CF, Rocha P, Melo T, Tavares B, Almeida E, Silva LD, Pereira TP, Delabie JH (2015) The ant community and their accompanying arthropods in cacao dry pods: an unexplored diverse habitat. Dugesiana 22 (1): 29–35. https://doi.org/10.32870/dugesiana.v22i1.4173

Delabie JH, Jahyny B, Nascimento IC, Mariano CS, Lacau S, Campiolo S, Philpott SM, Leponce M (2007) Contribution of cocoa plantations to the conservation of native ants (Insecta: Hymenoptera: Formicidae) with a special emphasis on the Atlantic Forest fauna of southern Bahia, Brazil. Biodiversity and Conservation 16 (8): 2359–2384. https://doi.org/10.1007/s10531-007-9190-6

Delabie JHC, Agosti D, Nascimento IC (2000) Litter ant communities of the Brazilian Atlantic rain forest region. In: Agosti D, Majer J, Alonso L, Schultz T (Eds.) Sampling

ground-dwelling ants: case studies from the world's rain forests. School of Environmental Biology, Bulletin 18: 1–17.

Economo EP, Klimov P, Sarnat EM, Guénard B, Weiser MD, Lecroq B, Knowles LL (2015) Global phylogenetic structure of the hyperdiverse ant genus *Pheidole* reveals the repeated evolution of macroecological patterns. Proceedings of the Royal Society B: Biological Sciences 282 (1798): 20141416. https://doi.org/10.1098/rspb.2014.1416

Feitosa RM, Morini MSC, Martins AC, Ribeiro TM, Noll FB, Santos EF, Cancello EM, Constantini JP (2021) Social insects of the Atlantic Forest. In: Marques MCM, Grelle CEV (Eds.) The Atlantic Forest. Springer, Cham, Switzerland, 151–183. https://doi.org/10.1007/978-3-030-55322-7

Fernandes TT, Dáttilo W, Silva RR, Luna P, Braz AB, Morini MSC (2020) Cohabitation and niche overlap in the occupation of twigs by arthropods in the leaf litter of Brazilian Atlantic Forest. Insectes Sociaux 67 (2): 239-47. https://doi.org/10.1007/s00040-020-00753-w

Fernandes TT, Dáttilo W, Silva RR, Luna P, Oliveira CM, Morini MSC (2019) Ant occupation of twigs in the leaf litter of the Atlantic Forest: influence of the environment and external twig structure. Tropical Conservation Science 12: 1940082919852943. https://doi.org/10.1177/1940082919852943

Hölldobler B, Wilson EO (1990) The ants. Belknap Press of Harvard University Press, Cambridge, USA, 732 pp.

Hortal J, Bello F, Diniz-Filho JAF, Lewinsohn TM, Lobo JM, Ladle RJ (2015) Seven shortfalls that beset large-scale knowledge of biodiversity. Annual Review of Ecology, Evolution and Systematics 46: 523–549. https://doi.org/10.1146/annurev-ecolsys-112414-054400

IBGE (Instituto Brasileiro de Geografia e Estatística) (2012) Manual técnico da vegetação brasileira: sistema fitogeográfico, inventário das formações florestais e campestres, técnicas e manejo de coleções botânicas, procedimentos para mapeamentos. 2nd edition. Coordenação de Recursos Naturais e Estudos Ambientais, Rio de Janeiro, Brasil, 276 pp.

Jahan MN, Rahman MM, Miah MG, Ahamed T (2022) Effects of vegetation types and habitat disturbance on species richness and form composition of ants (Hymenoptera, Formicidae) in Lawachara National Park, Bangladesh. Environment and Ecosystem Science 6 (1): 01–06. http://doi.org/10.26480/ees.01.2022.01.06

Janicki J, Narula N, Ziegler M, Guénard B, Economo EP (2016) Visualizing and interacting with large-volume biodiversity data using client-server web-mapping applications: The design and implementation of antmaps.org. Ecological Informatics 32: 185–193. https://doi.org/10.1016/j.ecoinf.2016.02.006

Ješovnik A, Bujan J (2021) Wooded areas promote species richness in urban parks. Urban Ecosystems 24 (6): 1305–1315. https://doi.org/10.1007/s11252-021-01112-8

Kempf WW (1961) A survey of the ants of the soil fauna in Surinam (Hymenoptera: Formicidae). Studia Entomologica 4: 81–524.

Kempf WW (1972) Catálogo abreviado das formigas da região neotropical (Hymenoptera: Formicidae). Studia Entomologia 15: 1–344.

Pacheco R, Silva RR, Morini MSC, Brandão CR (2009) A comparison of the leaf-litter ant fauna in a secondary atlantic forest with an adjacent pine plantation in southeastern Brazil. Neotropical Entomology 38 (1): 55–65. https://doi.org/10.1590/S1519-566X2009000100005

Ribeiro MC, Metzger JP, Martensen AC, Ponzoni FJ, Hirota MM (2009) The Brazilian Atlantic Forest: How much is left, and how is the remaining forest distributed? Implications for conservation. Biological Conservation 142 (6): 1141–1153. https://doi.org/10.1016/j.biocon.2009.02.021

Sánchez-Bayo F, Wyckhuys KA (2019) Worldwide decline of the entomofauna: a review of its drivers. Biological conservation 232: 8–27. https://doi.org/10.1016/j.biocon.2019.01.020

Santos RJ, Koch EBA, Leite CMP, Porto TJ, Delabie JHC (2017) An assessment of leaf-litter and epigaeic ants (Hymenoptera: Formicidae) living in different landscapes of the Atlantic Forest Biome in the state of Bahia, Brazil. Journal of Insect Biodiversity 5 (19): 1–19. https://doi.org/10.12976/jib/2017.5.19

Silva RR, Brandão CRF (2010) Morphological patterns and community organization in leaf-litter ant assemblages. Ecological Monographs 80 (1): 107–124. https://doi.org/10.1890/08-1298.1

Silva RR, Martello F, Feitosa RM, Silva OGM, Prado LP, Brandão CR, Albuquerque EZ, Morini MSC, Delabie JH, Monteiro ECS, Ribeiro MC (2022) Atlantic ants: a data set of ants in Atlantic Forests of South America. Ecology 103: e03580. https://doi.org/10.1002/ecy.3580

Souza-Campana DR, Wazema CT, Magalhães FS, Silva NS, Nagatani VH, Suguituru SS, Goto MA, Morini MSC (2020) Coleção de referência do Laboratório de Mirmecologia do Alto Tietê, São Paulo, Brasil: status atual e perspectivas. Boletim do Museu Paraense Emílio Goeldi-Ciências Naturais 15 (1): 317–336. https://doi.org/10.46357/bcnaturais.v15i1.274

Souza DR, Fernandes TT, Nascimento JR, Suguituru SS, Morini MSC (2012) Characterization of ant communities (Hymenoptera: Formicidae) in twigs in the leaf litter of the Atlantic rainforest and eucalyptus trees in the southeast region of Brazil. Psyche: a Journal of Entomology 2012: 1–12. https://doi.org/10.1155/2012/532768

Suguituru SS, Silva RR, Souza DRD, Munhae CDB, Morini MSC (2011) Ant community richness and composition across a gradient from *Eucalyptus* plantations to secondary Atlantic Forest. Biota Neotropica 11 (1): 369–376. https://doi.org/10.1590/S1676-06032011000100034

Suguituru SS, Souza DR, Munhae CD, Pacheco R, Morini MSC (2013) Ant species richness and diversity (Hymenoptera: Formicidae) in Atlantic Forest remnants in the Upper Tietê river basin. Biota Neotropica 13: 141–152. https://doi.org/10.1590/S1676-06032013000200013

Wagner DL (2020) Insect declines in the Anthropocene. Annual Review of Entomology 65: 457–480. https://doi.org/10.1146/annurev-ento-011019-025151

Wetterer JK (2007) Biology and impacts of Pacific Island invasive species. 3. The African big-headed ant, *Pheidole megacephala* (Hymenoptera: Formicidae) Pacific Science 61 (4): 437–456. https://doi.org/10.2984/1534-6188

(2007)61[437:baiopi]2.0.co;2

Wilson EO (1976) Which are the most prevalent ant genera. Studia Entomologica 19 (1–4): 187–200.

Wilson EO (2003) *Pheidole* in the New World: a dominant, hyperdiverse ant genus. Harvard University Press, Cambridge, USA, 794 pp.

Data Resources

The data underpinning the analysis reported in this paper are deposited in the Global Biodiversity Information Facility and are available at https://doi.org/10.15468/rv7tdk.